

corresponds to the velocity vector turn angle envelope.

§417.211 Debris analysis.

(a) *General.* A flight safety analysis must include a debris analysis. For an orbital or suborbital launch, a debris analysis must identify the inert, explosive, and other hazardous launch vehicle debris that results from normal and malfunctioning launch vehicle flight.

(b) *Launch vehicle breakup.* A debris analysis must account for each cause of launch vehicle breakup, including at a minimum:

- (1) Any flight termination system activation;
- (2) Launch vehicle explosion;
- (3) Aerodynamic loads;
- (4) Inertial loads;
- (5) Atmospheric reentry heating; and
- (6) Impact of intact vehicle.

(c) *Debris fragment lists.* A debris analysis must produce lists of debris fragments for each cause of breakup and any planned jettison of debris, launch vehicle components, or payload. The lists must account for all launch vehicle debris fragments, individually or in groupings of fragments whose characteristics are similar enough to be described by a single set of characteristics. The debris lists must describe the physical, aerodynamic, and harmful characteristics of each debris fragment, including at a minimum:

- (1) Origin on the vehicle, by vehicle stage or component, from which each fragment originated;
- (2) Whether it is inert or explosive;
- (3) Weight, dimensions, and shape;
- (4) Lift and drag characteristics;
- (5) Properties of the incremental velocity distribution imparted by breakup; and
- (6) Axial, transverse, and tumbling area.

§417.213 Flight safety limits analysis.

(a) *General.* A flight safety analysis must identify the location of populated or other protected areas, and establish flight safety limits that define when a flight safety system must terminate a launch vehicle's flight to prevent the hazardous effects of the resulting debris impacts from reaching any populated or other protected area and en-

sure that the launch satisfies the public risk criteria of §417.107(b).

(b) *Flight safety limits.* The analysis must establish flight safety limits for use in establishing flight termination rules. Section 417.113(c) contains requirements for flight termination rules. The flight safety limits must account for all temporal and geometric extents on the Earth's surface of a launch vehicle's hazardous debris impact dispersion resulting from any planned or unplanned event for all times during flight. Flight safety limits must account for all potential contributions to the debris impact dispersions, including at a minimum:

- (1) All time delays, as established by the time delay analysis of §417.221;
- (2) Residual thrust remaining after flight termination implementation or vehicle breakup due to aerodynamic and inertial loads;
- (3) All wind effects;
- (4) Velocity imparted to vehicle fragments by breakup;
- (5) All lift and drag forces on the malfunctioning vehicle and falling debris;
- (6) All launch vehicle guidance and performance errors;
- (7) All launch vehicle malfunction turn capabilities; and
- (8) Any uncertainty due to map errors and launch vehicle tracking errors.

(c) *Gates.* If a launch involves flight over any populated or other protected area, the flight safety analysis must establish a gate as required by §§417.217 and 417.218.

(d) *Designated debris impact limits.* The analysis must establish designated impact limit lines to bound the area where debris with a ballistic coefficient of three or more is allowed to impact if the flight safety system functions properly.

§417.215 Straight-up time analysis.

A flight safety analysis must establish the straight-up time for a launch for use as a flight termination rule. Section 417.113(c) contains requirements for flight termination rules. The analysis must establish the straight-up time as the latest time after liftoff, assuming a launch vehicle malfunctioned and flew in a vertical or near vertical

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direction above the launch point, at which activation of the launch vehicle's flight termination system or breakup of the launch vehicle would not cause hazardous debris or critical overpressure to affect any populated or other protected area.

§417.217 Overflight gate analysis.

For a launch that involves flight over a populated or other protected area, the flight safety analysis must include an overflight gate analysis. The analysis must establish the portion of a flight safety limit, a gate, through which a normally performing launch vehicle's tracking icon will be allowed to proceed. A tracking icon must enable the flight safety crew to determine whether the launch vehicle's flight is in compliance with the flight safety rules established under §417.113. When establishing that portion of a flight safety limit, the analysis must demonstrate that the launch vehicle flight satisfies the flight safety requirements of §417.107.

§417.218 Hold-and-resume gate analysis.

(a) For a launch that involves overflight or near overflight of a populated or otherwise protected area prior to the planned safe flight state calculated as required by §417.219, the flight safety analysis must construct a hold-and-resume gate for each populated or otherwise protected area. After a vehicle's tracking icon crosses a hold-and-resume gate, flight termination must occur as required by sections 417.113(d)(6).

(b) The hold-and-resume gate analysis must account for:

(1) *Overflight of a wholly contained populated or otherwise protected area.* A hold-and-resume gate must be a closed, continuous contour that encompasses any populated or otherwise protected area located wholly within the impact limit lines. The hold-and-resume gate must encompass a populated or otherwise protected area such that flight termination or breakup of the launch vehicle while the tracking icon is outside the gate would not cause hazardous debris or overpressure to endanger the populated or otherwise protected area.

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(2) *Overflight of an uncontained populated or otherwise protected area.* A hold-and-resume gate must be a closed, continuous contour that encompasses any area in which flight termination is allowed to occur. The hold-and-resume gate must encompass all hazard areas such that flight termination or breakup of the launch vehicle while the vehicle's tracking icon is inside the gate would not cause hazardous debris or critical overpressure to endanger any populated or otherwise protected area.

§417.219 Data loss flight time and planned safe flight state analyses.

(a) *General.* For each launch, a flight safety analysis must establish data loss flight times, as identified by paragraph (b) of this section, and a planned safe flight state to establish each flight termination rule that applies when launch vehicle tracking data is not available for use by the flight safety crew. Section 417.113(d) contains requirements for flight termination rules.

(b) *Data loss flight times.* A flight safety analysis must establish the shortest elapsed thrusting time during which a launch vehicle can move from normal flight to a condition where the launch vehicle's hazardous debris impact dispersion extends to any protected area as a data loss flight time. The analysis must establish a data loss flight time for all times along the nominal trajectory from liftoff through that point during nominal flight when the minimum elapsed thrusting time is no greater than the time it would take for a normal vehicle to reach the overflight gate, or the planned safe flight state established under paragraph (c) of this section, whichever occurs earlier.

(c) *Planned safe flight state.* For a launch vehicle that performs normally during all portions of flight, the planned safe flight state is the point during the nominal flight of a launch vehicle where:

(1) No launch vehicle component, debris, or hazard can impact or affect a populated or otherwise protected area for the remainder of the launch;

(2) The launch vehicle achieves orbital insertion; or

(3) The launch vehicle's state vector reaches a state where the absence of a